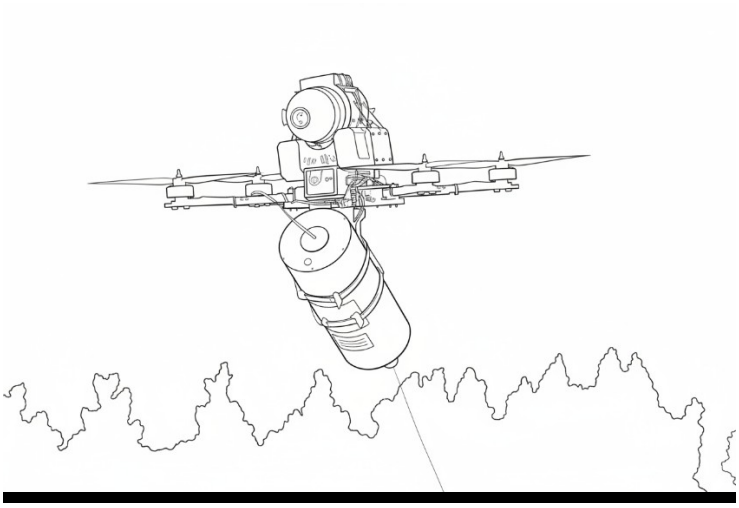
FPV Kamikaze Drone



Improvised First-Person View Commercial Racing Drone — One-Way Attack Weapon

[IMAGE: FPV kamikaze drone with RPG warhead — Ukrainian military Telegram channels / MOD press imagery]

Unit Cost (est.): $300–$800 per complete system including warhead | Cost Exchange Ratio vs. T-72 tank ($3M): up to 10,000:1 in attacker's favor

IDENTITY & DESIGNATION

Official Designation: No official designation — class of improvised weapon; also: FPV kamikaze, FPV suicide drone, FPV strike drone

Manufacturer: No single manufacturer — assembled by volunteer workshops, commercial drone companies, and military production facilities on both sides of the Ukraine conflict; also produced by Hamas, Hezbollah, Houthi forces, and others

Country of Origin: Ukraine and Russia (primary combat producers); global component supply chain

Year Introduced: Combat use from approximately 2022 in Ukraine conflict; scaled to mass production 2023–2024

Production Scale: Tens of thousands per month by both Ukraine and Russia as of 2024; Ukraine targeting one million FPV drones produced in 2024

Classification Note: This data card covers the FPV kamikaze as a weapon class — specific configurations vary by producer, theater, and available components

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CLASSIFICATION

Domain: Air

Category: Military / Improvised — One-Way Attack

Sub-Category: Commercial racing drone airframe modified for kamikaze strike mission

Terminal Mode: Expendable — operator-guided impact detonation

Expendable: Yes — one-way mission

Size Class: Micro / Small — typically 250g to 3kg total weight including warhead

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PHYSICAL SPECIFICATIONS

Configuration: Quadcopter (four brushless electric motors) — racing drone aerodynamic form; compact for agility and speed

Total Weight: Typically 1–3 kg including warhead; base airframe 250g–800g; warhead adds 300g–2kg

Dimensions: Typically 20–40 cm motor-to-motor diagonal; compact for transport and rapid deployment

Airframe Material: Carbon fiber frame and plastic composite — lightweight, minimal radar cross section

Warhead: Improvised — RPG-7 grenade (most common); anti-tank grenade; shaped charge; thermobaric device; fragmentation charge; warhead selection determines target effectiveness

Warhead Penetration: Dependent on warhead type — RPG-7 grenade: 300mm RHA equivalent penetration; designed for top and rear attack where armor is thinnest

Fuzing: Impact fuze standard; delay fuze variants; some fitted with proximity fuse for airburst anti-personnel effect

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PROPULSION & PERFORMANCE

Propulsion Type: Electric — four brushless motors; LiPo battery pack

Max Speed: 70–100 km/h standard combat configuration; racing builds 140+ km/h

Flight Time: 5–15 minutes depending on battery load, speed profile, and warhead weight

Range: 5–15 km limited by RF control link range and battery endurance

Operating Altitude: Low — typically 10–200 meters; terrain-following attack profile

Noise Signature: MODERATE — electric motors produce distinctive buzzing sound at close range; quieter than piston-engine platforms

GUIDANCE, NAVIGATION & CONTROL

Control Link (Standard): RF digital link — 2.4 GHz or 5.8 GHz; operator wears FPV goggles displaying real-time video from drone's forward camera; flies by visual reference in real time

Control Link (Fiber-Optic): Physical fiber-optic cable pays out behind drone during flight; jam-proof; no electromagnetic attack defeats a wire; limits range to cable spool length — typically 1–3 km for current systems

Navigation: No GPS dependency in standard configuration — operator navigates visually through FPV camera feed; GPS spoofing completely irrelevant

Terminal Guidance: Human operator guides impact in real time; operator skill is the entire guidance system

Autonomy Level: NONE — fully human-controlled throughout flight; no autonomous modes in standard configuration

Operator Skill: MODERATE — requires FPV pilot training; experienced operators achieve high hit rates; training cycle measured in weeks not years

Man-in-Loop Required: Yes — always; human operator confirms and executes target engagement

Fiber-Optic Option: Yes — field modification widely adopted in Ukraine; eliminates RF jamming vulnerability entirely

SENSORS & PAYLOADS

Primary Sensor: Forward-facing FPV camera — analog or digital video; real-time feed to operator goggles; resolution sufficient for target identification at operational ranges

Additional Sensors: Some variants carry downward-facing cameras for navigation and target assessment; rarely carry IR cameras due to weight and cost constraints

Payload: Warhead only — improvised explosive device configured for mission; no ISR payload in kamikaze configuration

Dropping Variants: Some FPV platforms configured as munition droppers rather than kamikazes — drop grenades or bomblets and return; not covered in this card

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COUNTERMEASURE VULNERABILITY PROFILE

RF Jamming: HIGH (standard RF variant) — primary vulnerability; interrupt the control signal and the drone loses guidance, crashes, or flies straight until battery exhaustion. Russian EW systems specifically optimized for FPV control frequencies. VERY LOW (fiber-optic variant) — no RF link to jam; physical cable is immune to all electromagnetic attack

GPS Spoofing: VERY LOW — standard FPV kamikazes do not use GPS; operator guides visually in real time; GPS spoofing is completely irrelevant against this platform

EMI/EMC Attack: HIGH — commercial electronics with zero hardening; flight controller, ESC motor controllers, FPV camera, video transmitter all consumer-grade; no EMI shielding; directed microwave attack crashes the drone immediately. MODERATE for hardened Ukrainian-produced variants with improved EMI resistance

Microwave Attack: HIGH — unhardened commercial electronics; compact airframe packs all vulnerable components closely together with minimal shielding; HPM disruption effective

Laser DEW: MODERATE — small cross-section; fast in attack profile; difficult to track and maintain dwell time on maneuvering target; engagement window opens at 500–800 meters; closing speed reduces dwell time below 300 meters

Kinetic Intercept: MODERATE to HIGH — small target; fast; near-zero radar cross section from composite construction; visual detection is primary method; shotguns, rifles, and net-equipped

interceptor drones have achieved engagement; volume of simultaneous attacks creates magazine depth problem

Net / Physical Capture: LOW to MODERATE — too fast and maneuverable in terminal attack for most net systems; some success with net-equipped interceptor drones engaging before terminal geometry

Cyber / Hack: LOW — simple commercial flight controller with no network connectivity; nothing sophisticated to exploit. MODERATE for advanced variants with network features

Cope Cage: PARTIALLY EFFECTIVE — wire mesh cages around armor can trigger impact-fused RPG warhead before reaching armor surface; less effective against delay-fused or standoff-detonating warheads; both sides actively iterating warhead configuration versus cage design

Active Camouflage Defeat: N/A — operator guides by visual reference; no seeker to defeat

Overall Vulnerability Rating: HIGH (standard RF variant) — primary vulnerability is the RF control link; EMI and microwave attacks are also effective. MODERATE (fiber-optic variant) — RF link eliminated; EMI and microwave remain. The volume of simultaneous deployments makes individual intercept insufficient at tactical scale

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CRUISE MISSILE CONVERGENCE NOTES

The FPV kamikaze makes the convergence thesis from the most unexpected direction in this entire book. Every other platform covered here began with designed military capability and converged toward drone specifications. The FPV kamikaze began as a sport. Commercial racing drone pilots developed the airframe, motors, controllers, goggles, and video systems — all for the pleasure of flying fast through obstacle courses. Military adoption required no re-engineering of the fundamental platform. It required strapping a grenade to the front. The result is the

most cost-effective tactical strike weapon in the history of land warfare. At three hundred dollars against a three million dollar tank the cost-exchange ratio reaches ten thousand to one in the attacker's favor. No weapon system in history has achieved this ratio at tactical scale. The convergence thesis argues that drone capability is climbing toward cruise missile capability. The FPV kamikaze inverts the question — it demonstrates that the commercial hobby market, optimizing for completely civilian purposes, inadvertently created a weapon system that outperforms many purpose-built military munitions in cost-effectiveness per engagement. The defense industry did not do this. Hobbyists did.

ENGINEER'S NOTE: *The FPV kamikaze is the platform that most directly challenges the assumption that effective weapons require sophisticated design. Every RF-guided weapon I worked on during my career — Tomahawk variants, the Advanced Cruise Missile — was designed around the problem of getting a guidance signal to the weapon reliably in a contested electromagnetic environment. The FPV kamikaze solves that problem by eliminating the guidance system entirely and replacing it with a human being wearing goggles. The fiber-optic evolution is the engineering insight that completes this platform. A physical cable is immune to every electronic countermeasure ever developed. You cannot jam a wire. You cannot spoof a wire. You cannot cyber-attack a wire. The entire electronic warfare doctrine developed over seventy years of Cold War investment becomes irrelevant against a three-hundred-dollar drone connected to its operator by a cable that costs less than a dollar per meter. The supply chain lesson is equally important. Ukraine needed to produce*

hundreds of thousands of these per month. The supply chain was already there — in hobby shops, commercial drone companies, and the same global component market that serves racing pilots worldwide. The manufacturing base for the most widely deployed strike weapon of the current conflict is the global hobby drone industry. That is a sentence that should appear in every defense acquisition reform document written in the next decade.

OPERATIONAL HISTORY

Ukraine 2022: Initial combat deployment by Ukrainian forces for ISR and light strike; early configurations improvised from available commercial components

Ukraine 2023: Rapid scaling on both sides; Ukraine and Russia both producing tens of thousands per month; FPV becomes dominant tactical strike weapon displacing artillery for many close-range engagements

Ukraine 2024: Ukraine targets one million FPV drones produced domestically; fiber-optic control links widely adopted in response to Russian jamming; domestic Ukrainian manufacturers emerge producing hardened variants; both sides deploy FPV interceptor drones to hunt enemy FPVs

Frequency Adaptation: As Russia jammed standard 2.4 GHz and 5.8 GHz bands, Ukrainian operators switched frequencies, changed protocols, and moved to fiber-optic links; entire adaptation cycle completed in weeks

Gaza 2023–2024: Hamas and allied forces deploy FPV kamikaze variants for urban strike missions; significantly lower scale than Ukraine but demonstrating proliferation beyond conventional state militaries

Houthi Operations: Houthi forces deploy FPV-class drones in Red Sea and Yemen conflict theater; technology transfer from Iranian supply chain

Cost Comparison: Ukraine deploys FPV kamikazes at approximately one thousand to one ratio versus Switchblade 600 — not because Switchblade is inferior but because economics allow FPV scale that precision systems cannot match

Tactical Evolution: FPV kamikazes increasingly used for: direct armor attack via top and rear; personnel engagement; vehicle destruction; IED emplacement; artillery position strikes; first-responder denial (attacking crews attempting to recover damaged vehicles)

SOURCES & CROSS-REFERENCES

Volume 1 Reference: Chapter 6 Section 6.2 — Small Loitering Munitions tactical tier analysis; FPV kamikaze vs Switchblade 600 vs Hero-120 comparison

Ukraine Production: Ukrainian government statements on one million drone production target 2024; multiple defense media sources

Fiber-Optic Development: Ukrainian MOD Methodological Recommendations on Electronic Counteraction to Unmanned Aerial Vehicles; field reporting from multiple conflict correspondents

Cost Data: Multiple defense analysis sources; range reflects variability in component quality and warhead type

[VERIFY]: Exact production figures for both sides classified; performance specifications vary significantly by build configuration; cost range reflects wide variation in component sourcing

Cross-Ref: See also: Switchblade 600 (US precision loitering munition comparison); Lancet-3 (Russian precision loitering munition comparison); DJI Mavic 4 Pro (base commercial platform

often modified); FPV interceptor drones (counter-FPV doctrine); fiber-optic control link technology; Chapter X supply chain lessons